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Reele

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(54) **THERMAL PRINTER WITH BI-DIRECTIONAL PRINT HEAD MOVEMENT AND METHOD THEREOF**

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Related U.S. Application Data

(63) Continuation of application No. 09/314,387, filed on May 19, 1999, now abandoned.

(51) **Int. Cl.**[7] **B41J 11/00**; B41J 2/325
(52) **U.S. Cl.** **347/174**; 347/176
(58) **Field of Search** 347/174, 173, 347/171, 172, 175–176; 400/120.02, 120.03, 120.04, 120.01; 358/503

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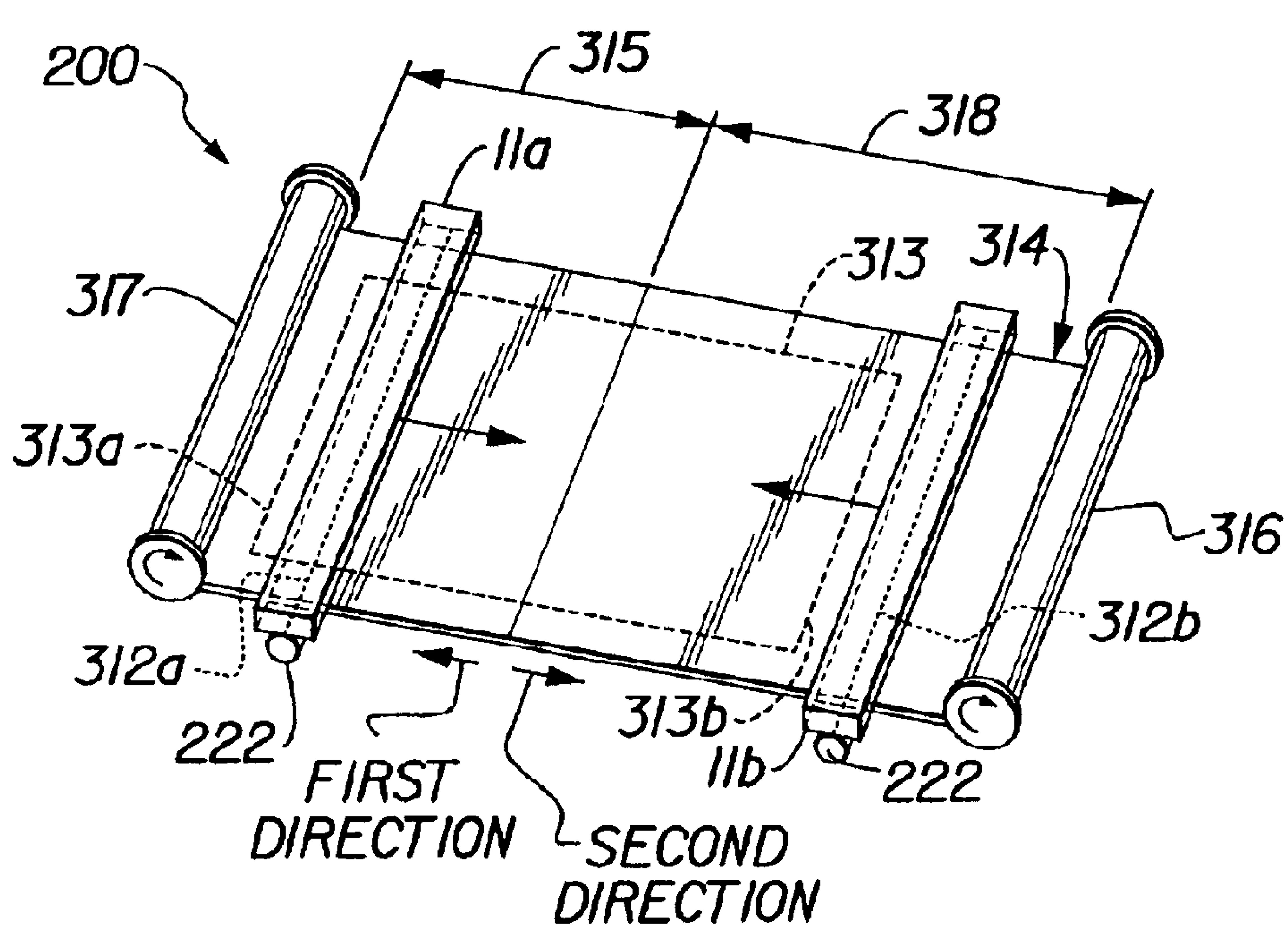
(57) **ABSTRACT**

A printer and method of generating hard copy comprising only one ejection step from either a thermal printing mechanism using one print head or a thermal printing mechanism using first and second thermal printing heads. The thermal printing mechanism with one printing head operates bilaterally. Alternatively, the thermal printing mechanism simultaneously operates dual thermal printing heads with only one ejection for release of a thermally sensitive hard copy output media.

7 Claims, 4 Drawing Sheets



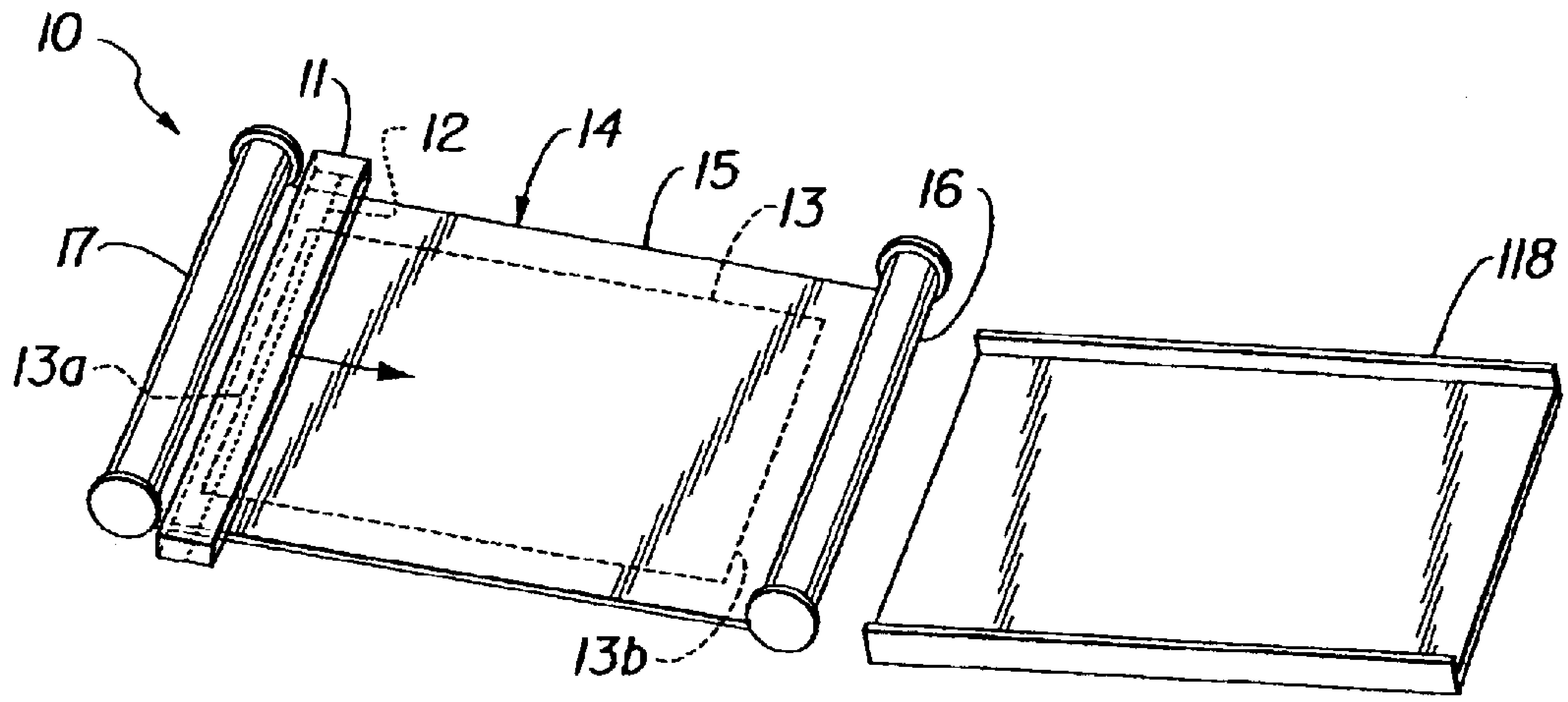


FIG. 1a
(PRIOR ART)

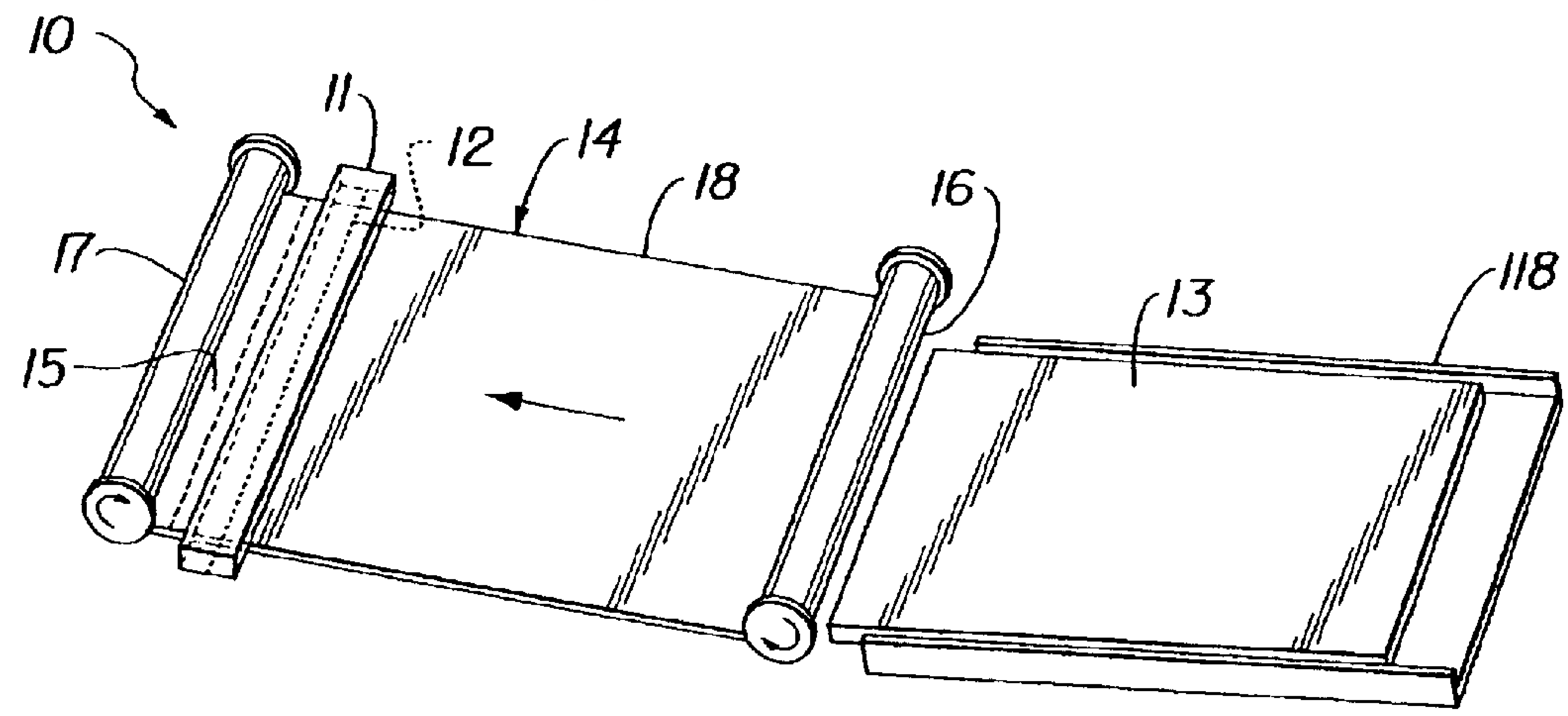


FIG. 1b
(PRIOR ART)

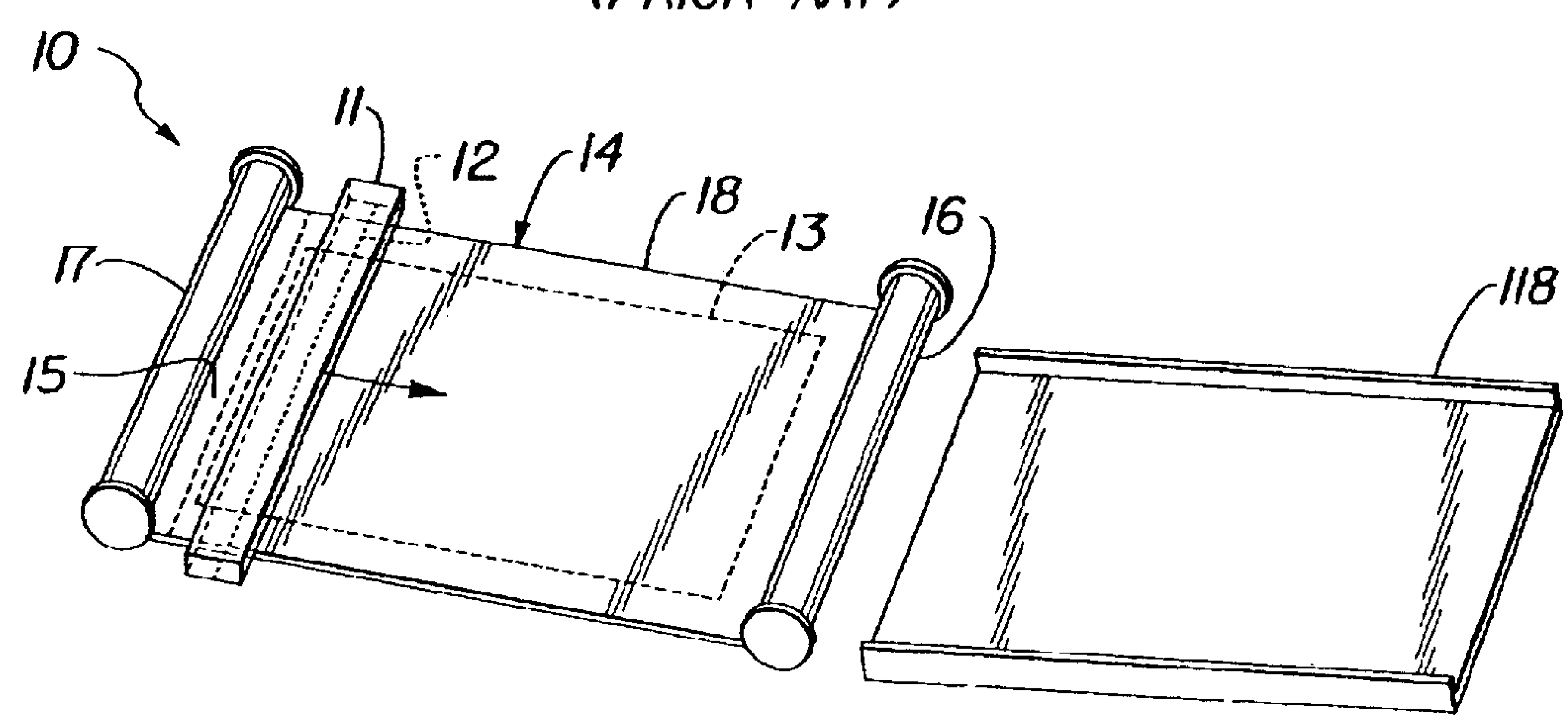


FIG. 1c
(PRIOR ART)

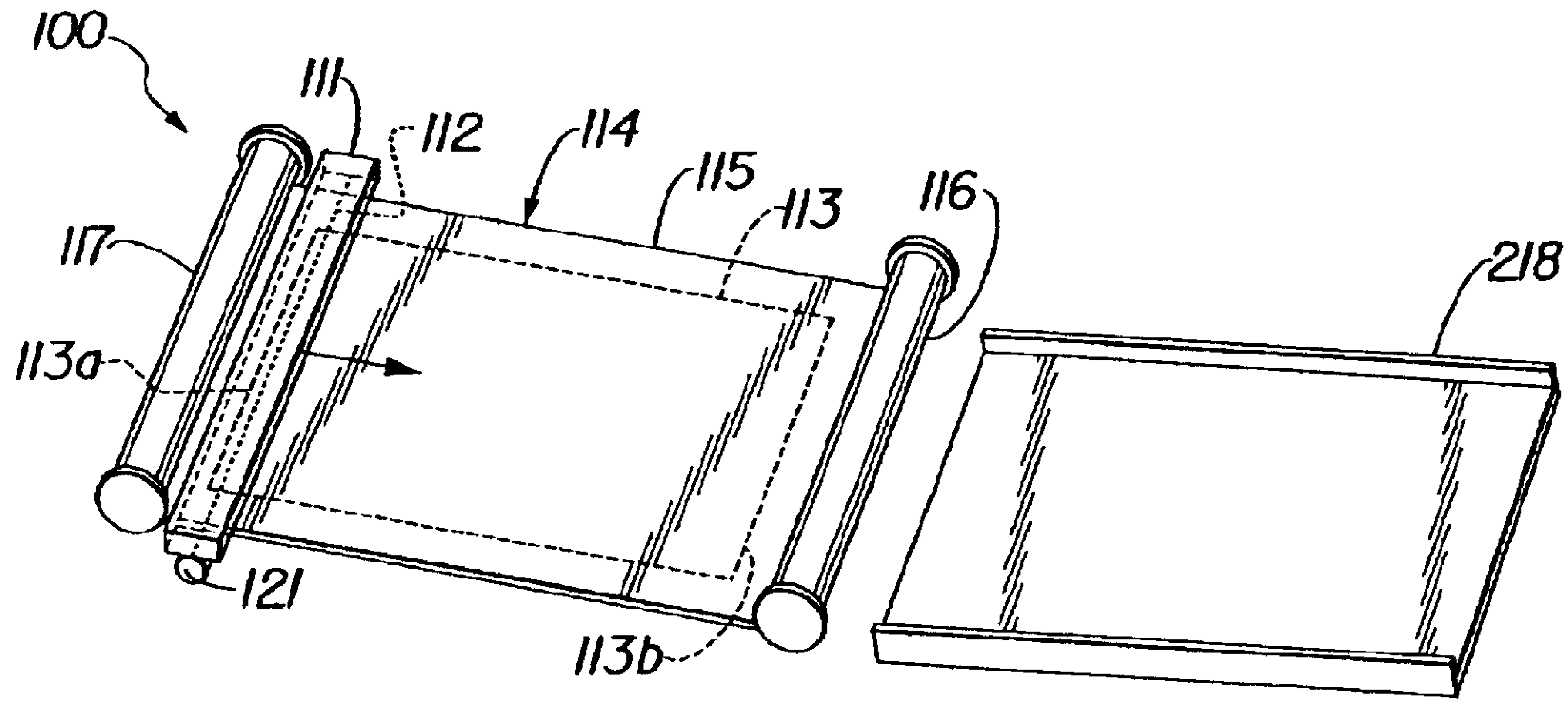


FIG. 2a

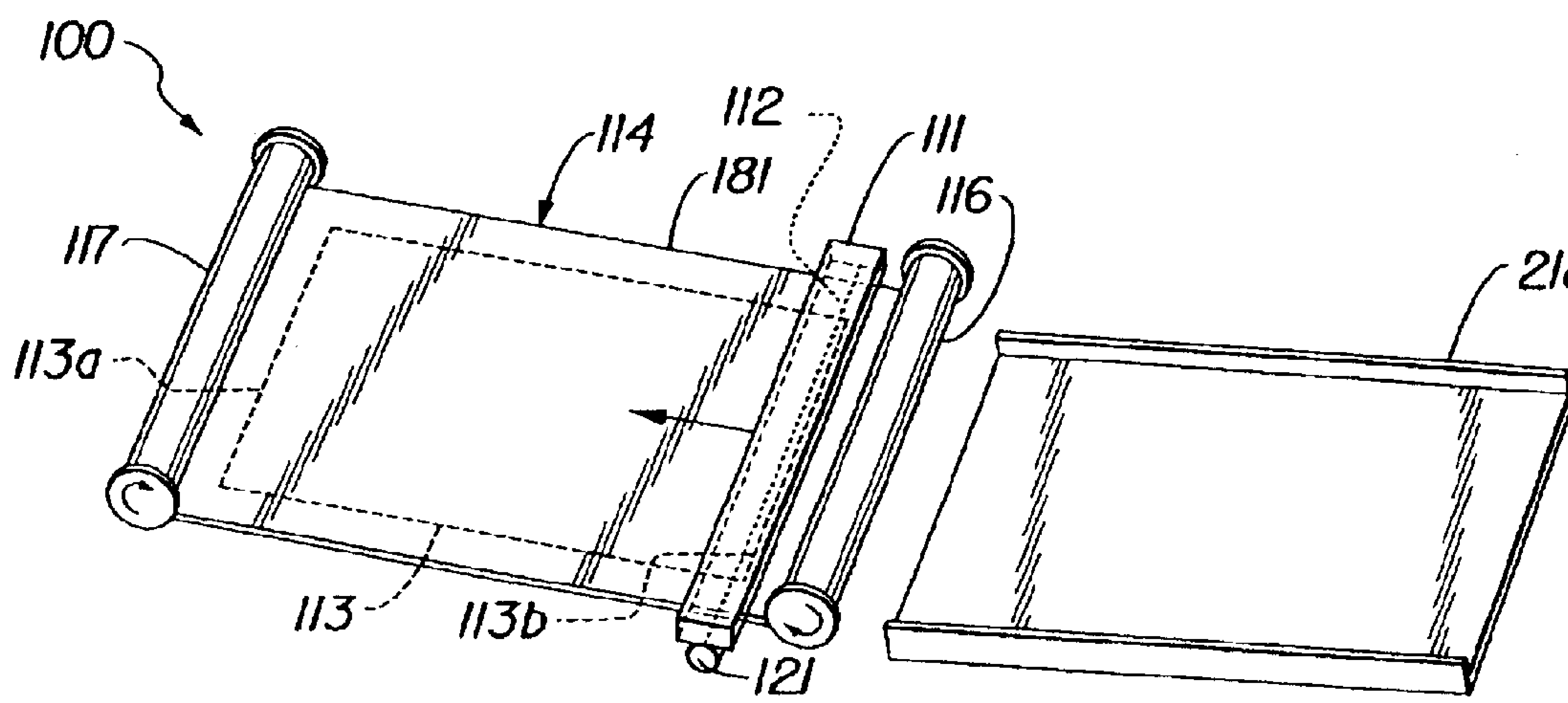


FIG. 2b

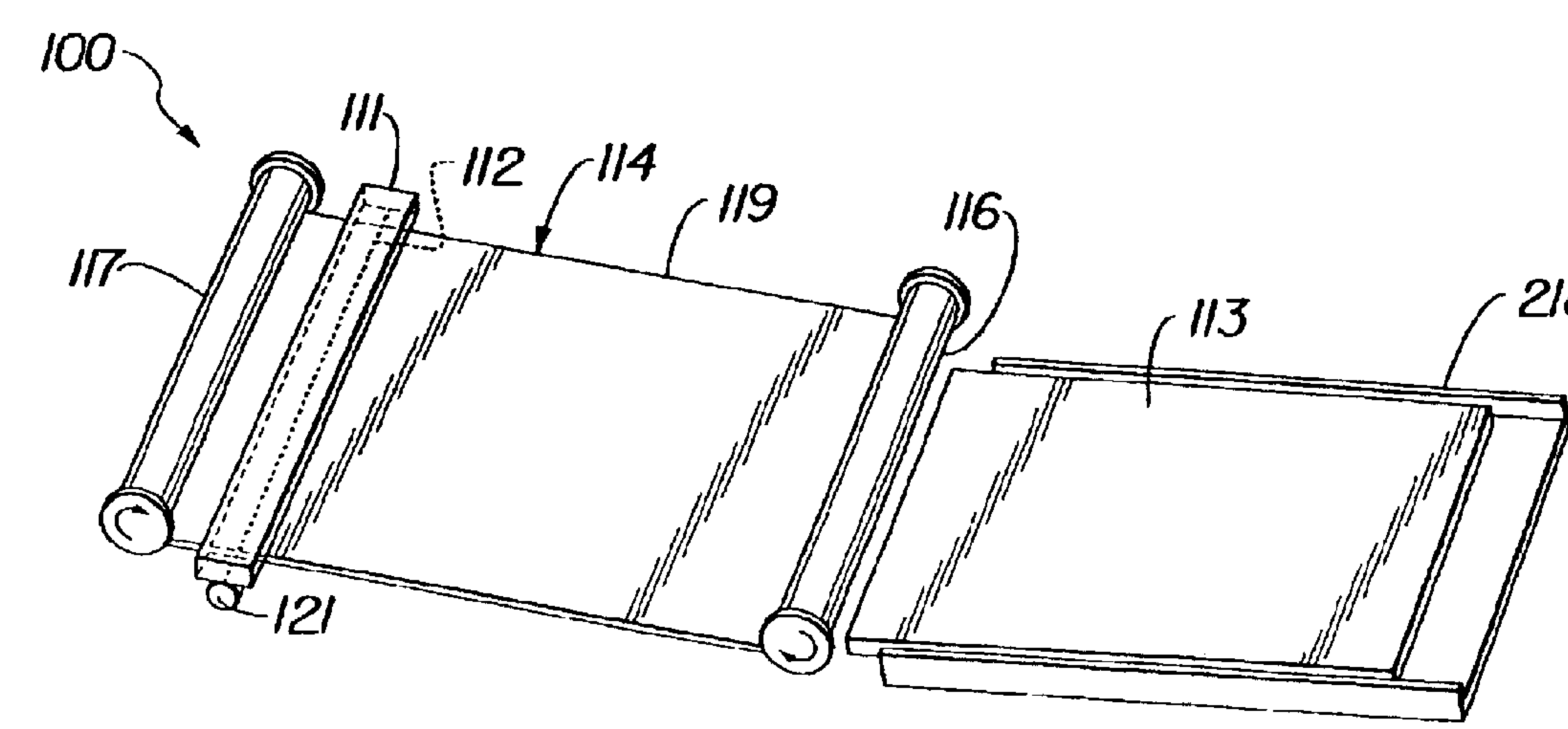


FIG. 2c

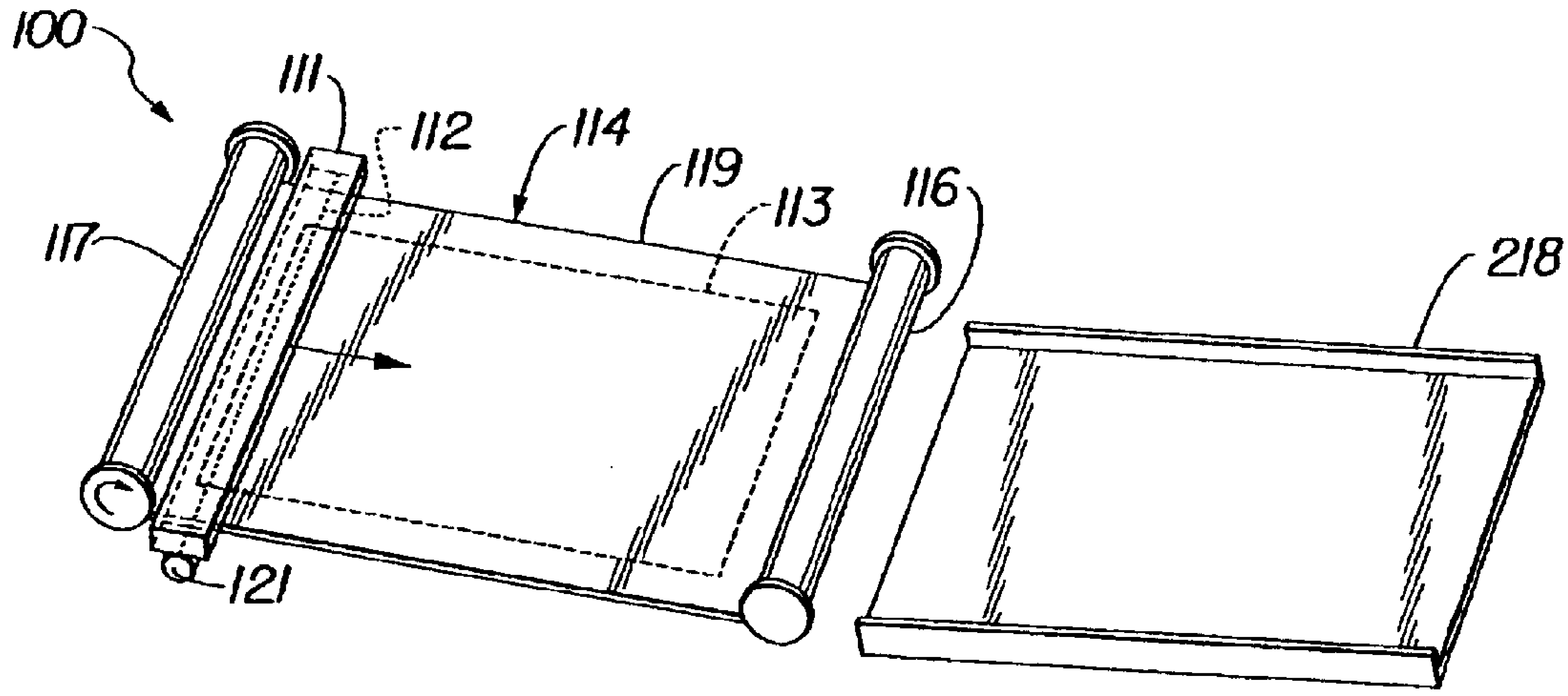


FIG. 2d

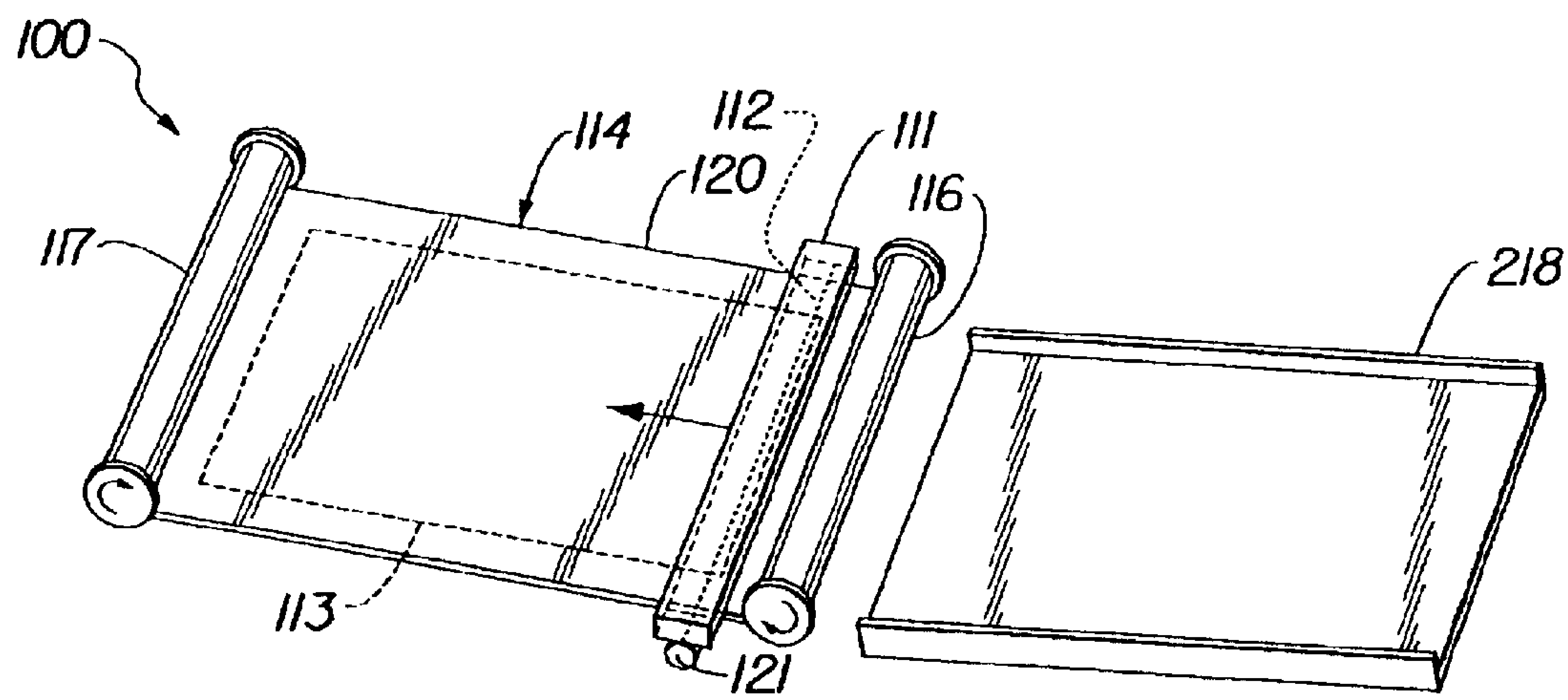


FIG. 2e

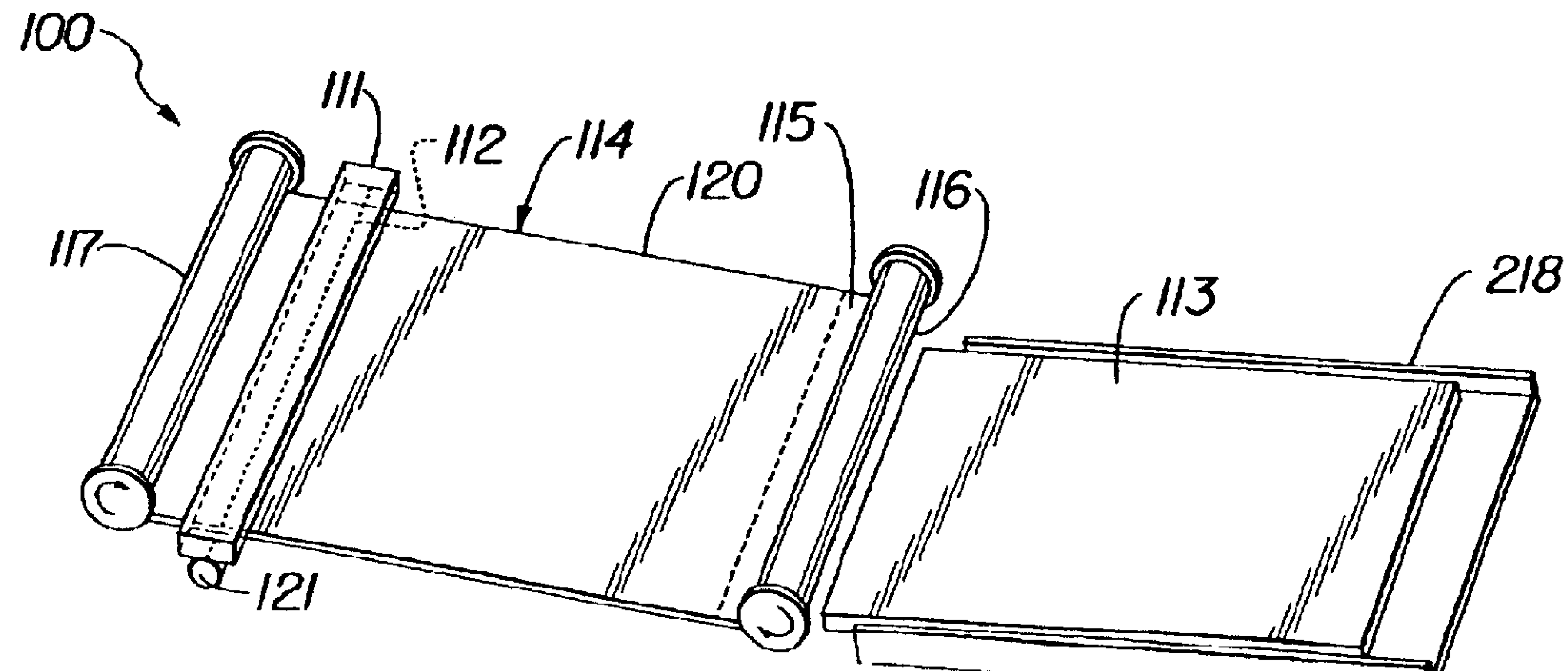


FIG. 2f

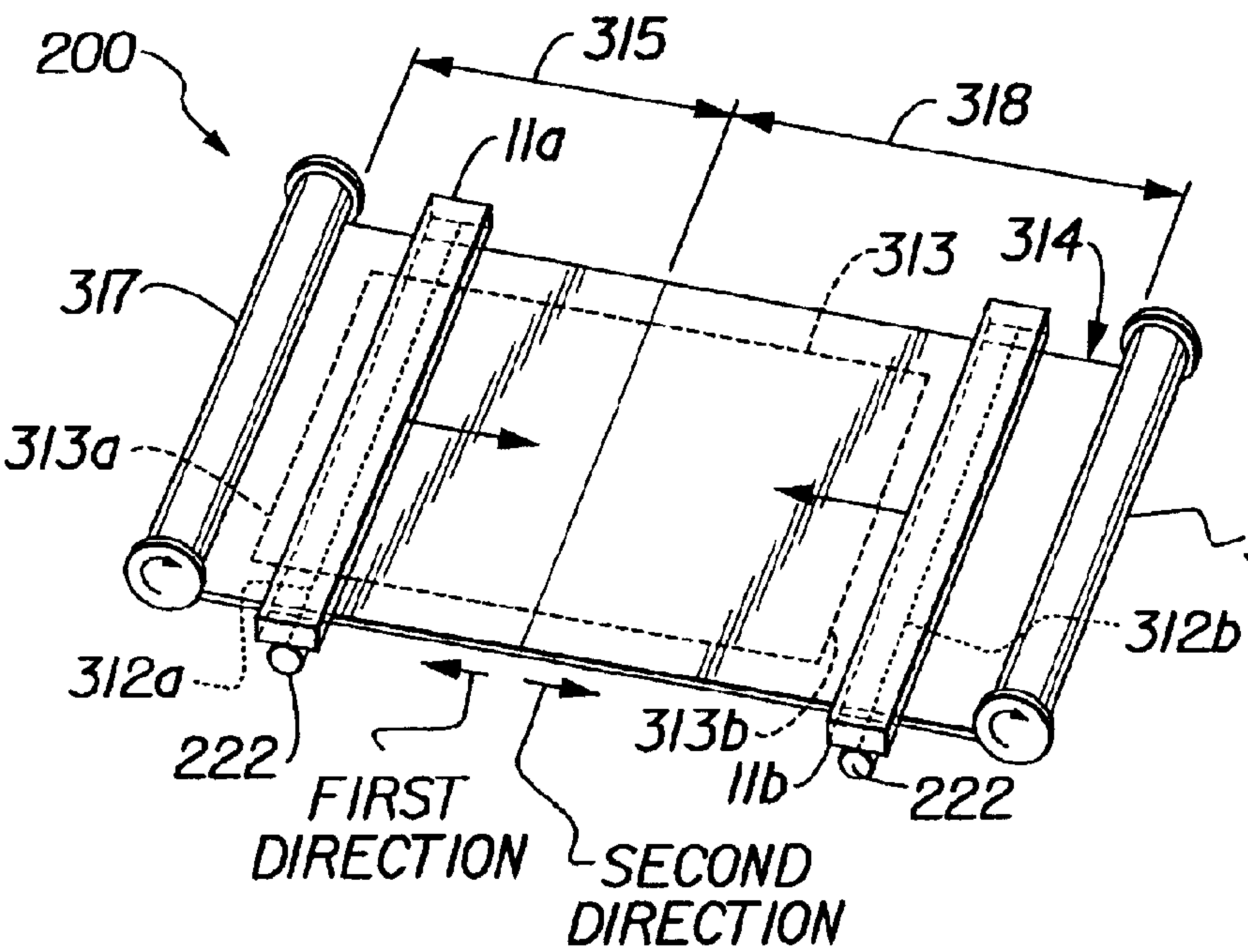

200
315
318
11a
313
314
317
313a
316
312b
312a
222
313b
11b
222
FIRST DIRECTION
SECOND DIRECTION

FIG. 3

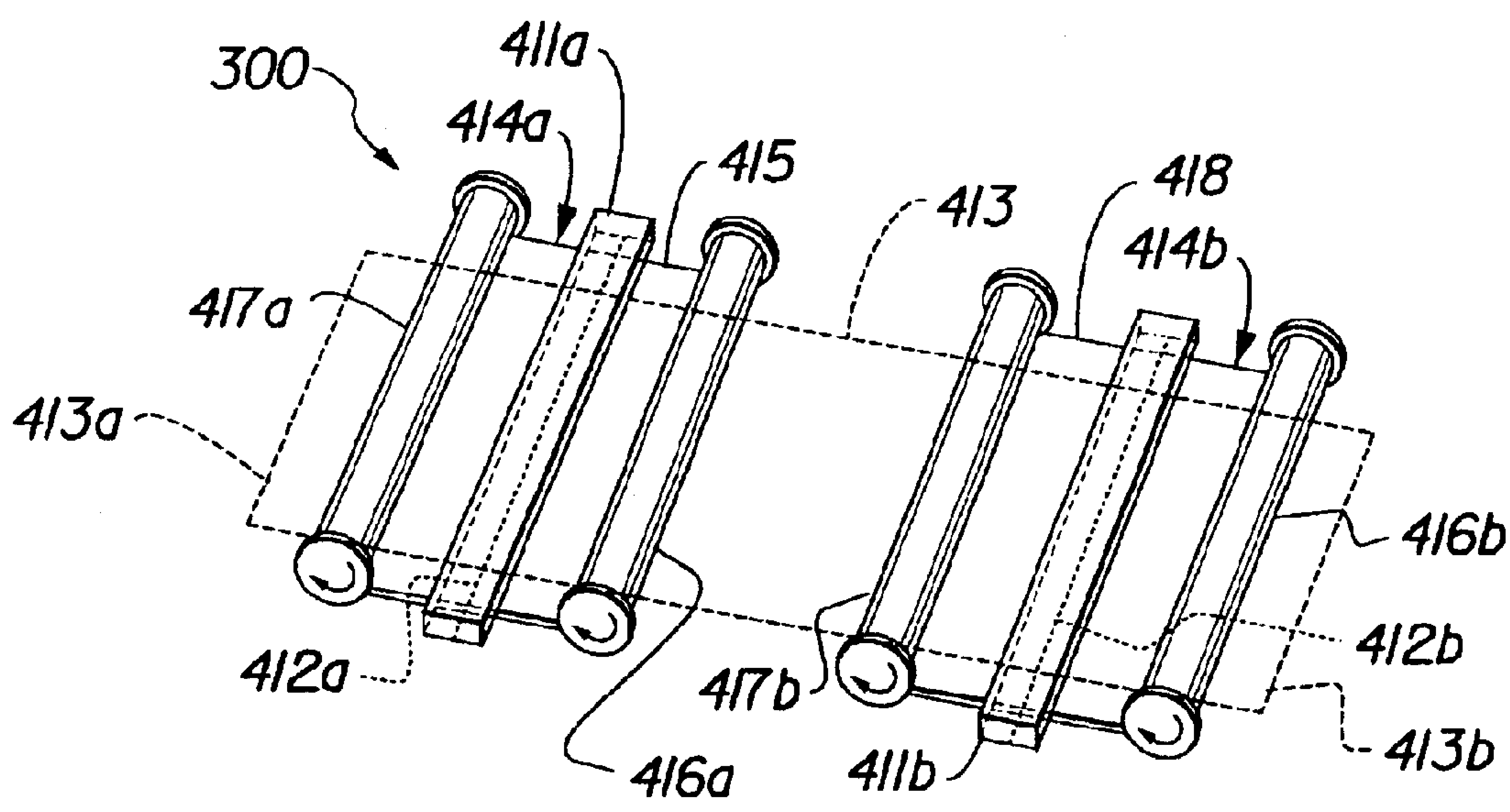

300
411a
414a
415
413
418
414b
417a
413a
416b
412b
412a
417b
413b
416a
411b

FIG. 4

THERMAL PRINTER WITH BI-DIRECTIONAL PRINT HEAD MOVEMENT AND METHOD THEREOF

This application is a continuation application of U.S. application Ser. No. 09/314,387, filed May 19, 1999 and now abandoned.

FIELD OF THE INVENTION

The present novel invention relates generally to a thermal printer adapted to more efficiently print a thermal hard copy output resulting in less time to produce a thermal print. More specifically, the present invention relates to a thermal printing mechanism and method of utilizing a bilateral single head printer or multiple heads for printing alternate or multiple rows simultaneously in multiple colors.

BACKGROUND OF THE INVENTION

Technology related to the novel invention is disclosed in Japan Patent No. 8,072,282 assigned to Fuji. Also, U.S. Pat. No. 5,367,321 assigned to Kyocera, discloses an electrical circuit system comparable to that used in the novel improved invention. The problem of improving print speed in related printers is addressed in both Japan Patent No. 6,127,267 assigned to Sharp and U.S. Pat. No. 4,774,529 assigned to Xerox. Of further background relevance are Japan Patent No. 7,214,870 assigned to Brother Kogyo; U.S. Pat. No. 5,196,864 assigned to Eastman Kodak; and, Japan Patent No. 7,184,410 assigned to Silver Seiko.

More relevant is Japan Patent No. 8,072,282 which discloses the use of three staggered print heads arranged linearly to improve print speed and Japan Patent No. 6,127,267 wherein two parallel electrodes provide simultaneous recording. Japan Patent No. 7,214,870 also discloses an arrangement wherein one or more print heads are arranged in parallel.

For additional background purposes, U.S. Pat. No. 5,367,321 issued to Shigenori, et al. discloses multiple insulating substrates to form a linear heating element in a thermal printer and U.S. Pat. No. 4,774,529 suggests a printing system for increasing the speed of a multi-color printer when utilized in a single color mode by repositioning the recording head cartridge from a first level to a second level to enable two lines of information to be created during a single scanning pass when it has been determined by the electronic means to be of the same color.

Other art appears in U.S. Pat. No. 5,196,864 wherein a multiple print head thermal printer is disclosed.

U.S. Pat. No. 4,946,297; U.S. Pat. No. 5,000,595; and, Japan Patent No. 7,184,410 refer to the use of four separate line print heads being mounted and teaches how to split a line into four prints using four separate print heads and then joining the line together.

Today's thermal printers are designed with one thermal head and multiple donor media types. Typically, the donor media is composed of multiple areas of different donor material which are mechanically linked in a specific sequential order. Typically, three areas of color specific donor material are required for a photographic quality thermal hard copy print. For a typical donor today, that sequence of color specific donor material may be yellow, magenta, and cyan. Other donor materials may be composed of a base sequence of four color specific donor areas: yellow, magenta, cyan, and black. The particular sequence of donor material (whatever that may be) is repeated in a serial fashion to complete a roll of donor material.

Referring to prior art, FIG. **1**, in producing a thermal hard copy output, donor material (usually the least thermally active color, yellow **15**) is positioned over the thermal paper **13**. Mechanical rollers **16** and **17**, edge and color sensors are used to recognize and position the desired donor material color over the thermal output paper. A thermal head **11**, in which pixels **12** (typically 300 per inch) are arranged in a linear fashion, is positioned at the edge of the thermal paper. Digitized control data is then applied to each pixel simultaneously (usually pulse modulated) such that a row or line of one color is printed onto the thermal paper. Through stepper motors and mechanics, and control logic, for example, such as disclosed by the electrical circuit system in Kyocera which is adopted and incorporated herein by reference, either the thermal print head or thermal output paper is advanced one line or row and the thermal transfer process is repeated for that row. This whole sequence is repeated until one color is thermally transferred onto one full sheet of desired thermal output paper. The thermal paper is projected, as shown in prior art FIG. **1***b*, donor material is advanced to the next color area, and the thermal output paper is re-inserted, as shown in prior art FIG. **1***c*. The entire process is repeated until the next color (for example, magenta **18**) in the sequence is transferred onto the thermal output paper. This process is repeated again with donor material advancing to the next color area until all colors of the donor material are transferred or thermally printed onto the thermal output paper. The problem with this process is that it requires a relatively lengthy time period to complete. More particularly, it is time-consuming, mechanically intensive and requires four paper projections for a donor composed of four independent color areas per each thermal print.

The novel invention resolves the problem of lengthy time consumption and four paper projections for a donor composed of three independent color areas for each thermal print. Specifically, the novel invention significantly reduces the required projections and mechanical steps, and thereby the printing time necessary for a thermal printer to produce a thermal print.

SUMMARY OF THE INVENTION

An object of this invention is to provide a novel combination of steps in a thermal printer printing process wherein the output paper is retained and thermal printing occurs in a bilateral direction instead of a unilateral direction and wherein the output paper is ejected after the application of each color.

This object is achieved by a novel integration of a preferred embodiment thermal printer mechanism having a donor media which contains a yellow media section, a magenta media section, a cyan media section, and a black media section, all of which are positioned mechanically between the thermal print head and the thermal output media by the rotation of two roller spools. In addition, the thermal print head contains a mounting mechanism that works like a universal socket wherein the thermal head is precisely positioned over the donor media at the correct angle when the head is traveling in a left to right motion as well as a right to left motion. The stepper motor control is adapted to direct a bi-directional stepper motor and comprises the electronics therefor.

One of the most outstanding advantages of the present invention is that the use of the above described mechanical and electrical combination significantly increases the printing speed of thermal head printers approximately 30% or more.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1***a* is a perspective view of a first aspect of an internal printing mechanism in a prior art printer;

FIG. **1***b* is a perspective view of a second aspect of the internal printing mechanism in the prior art printer;

FIG. **1***c* is a perspective view of a third aspect of the printing mechanism in the prior art printer;

FIG. **2***a* is a perspective view of a first aspect of an internal printing mechanism which depicts a first preferred embodiment of a printing mechanism of the novel invention;

FIG. **2***b* is a perspective view of a second aspect of the internal printing mechanism which depicts the first preferred embodiment of the printing mechanism of the novel invention;

FIG. **2***c* is a perspective view of a third aspect of the internal printing mechanism which depicts a first preferred embodiment of the printing mechanism of the novel invention;

FIG. **2***d* is a perspective view of a fourth aspect of the internal printing mechanism which depicts the first preferred embodiment of the printing mechanism of the novel invention;

FIG. **2***e* is a perspective view of a fifth aspect of the internal printing mechanism which depicts the first preferred embodiment of the printing mechanism of the novel invention;

FIG. **2***f* is a perspective view of a sixth aspect of the internal printing mechanism which depicts the first preferred embodiment of the printing mechanism of the novel invention;

FIG. **3** depicts a first alternative embodiment wherein separate multiple thermal heads and a single donor media spool are utilized for printing; and,

FIG. **4** depicts a second alternative embodiment wherein juxtaposed multiple thermal heads and multiple donor media spools are utilized for printing.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. **1***a* there is shown a printer mechanism **10** of a prior art printer and an illustration of the prior art method of operation. As further shown in greater detail in FIGS. **1***a,* **1***b,* and **1***c,* these prior art thermal printers were designed to produce hard copy output **13** starting at a leading edge **13***a* and printing to a trailing edge **13***b* with one thermal head **11**, thermal heating elements (or pixels) **12**, and multiple donor media **14**.

Typically the donor media **14** of the prior art as illustrated in FIGS. **1***a,* **1***b,* and **1***c* are composed of multiple areas of the donor media **14** which are mechanically linked in a specific sequential order. There is shown a yellow donor media **15** located in between a first donor media spool **16** and a second donor media spool **17**. There also is a magenta donor media **18**. As illustrated in FIGS. **1***a* and **1***b,* in the prior art at least two areas of color specific donor media **14** are required for a photographic quality thermal hard copy print. For typical donor media **14** today, that sequence of color specific donor material is yellow, magenta, and cyan. Other donor materials may be composed of a base sequence of four color specific donor areas: yellow, magenta, cyan, and black. The particular sequence of donor material (whatever that may be) is repeated in a serial fashion to make up a complete roll or spool of donor material.

In producing the thermal hard copy output **13** , donor material (usually the least thermally active color) is first positioned over the hard copy output **13**, e.g. thermal paper. Mechanical rollers, edge and color sensors are used to recognize and position the desired donor material color over the thermal output paper. A thermal head, in which pixels (typically 300 per inch) are arranged in a linear fashion, is positioned at the edge of the thermal paper. Digitized control data is then applied to each pixel simultaneously (usually pulse modulated) such that a row or line of one color is printed onto the thermal paper. Using stepper motors and mechanics, and control logic well known in the art, either the thermal print head **11** or the hard copy output **13** or thermal paper is advanced one line or row and then the thermal transfer process is repeated for that line or row. This whole well known sequence is repeated until one color is thermally transferred onto one full sheet of desired hard copy output **13**. The thermal paper is projected, donor material is advanced to the next color area, magenta **18**, as shown in FIG. **1***b.* The hard copy output **13** or thermal output paper as shown in FIG. **1***b* is re-inserted and the magenta color is printed as shown in FIG. **1***c.* The entire process is repeated until the next color in the sequence is transferred onto the thermal output paper. As shown in FIGS. **1***b* and **1***c,* this well known prior art process is repeated again with donor material advancing to the next color area of a plurality of color areas issuing from the first donor media spool **16** to the second donor media spool until all colors of the donor media **14** are transferred or thermally printed onto the hard copy output **13** or thermal output paper.

The above described prior art process as generally illustrated in FIGS. **1***a,* **1***b,* and **1***c* is characterized by engineers in the art as mechanically intensive because this prior art process requires no less than four (4) paper projections for a donor composed of a like number or three (3) independent color areas for each full color thermal print (typically a clear coat is printed over all colors). The resulting prior art process, as briefly shown in FIGS. **1***a,* **1***b,* and **1***c,* is a thermal process requiring an extended period of time, To. The novel invention as illustrated in FIGS. **2***a,* **2***b,* **2***c,* **2***d,* **2***e,* **2***f* and FIGS. **3** and **4** significantly reduces the processing time T_0 by approximately 20% to 50% to a new processing time T_N. Thereby, with the novel arrangement of donor elements and printing heads illustrated in FIGS. **2***a* through **4**, printing time for a thermal printer is significantly and substantially reduced such that $T_0-(0.20)T_0=T_N$.

Referring again to FIG. **1***a,* a detailed description of the prior art printing process is as follows. The prior art printing mechanism **10** contains a thermal head **11** which contains thermal heating pixels. There are 300–440 elements **12** or pixels per inch in density, for example. The mechanism **10** also contains a thermally active donor material **14** which is mechanically positioned between the thermal head **11** and the hard copy output media **13**, for example thermal paper. A specific color from the donor material **14** is provided by advancing (virgin) donor material **14** of various colors such as yellow **15** via two spools **16** and **17**, respectively. When completed, the hard copy output media **13** or thermal paper is ejected from the printing mechanism **10** housed internally in a printer housing (not shown for clarity) and positioned onto a customer retrieval shelf **118**.

As previously described, the prior art sequence and method of printing is depicted in FIGS. **1***a,* **1***b,* and **1***c.* Specifically, in FIG. **1***a,* the thermal head **11** commences a first step of printing by transferring yellow donor media **15** at the leading edge **13***a* opposite from the trailing edge **13***b* associated with the hard copy output **13**. Via a single linear array of the individual elements **12**, pulse width modulation commands, the thermally active donor material **14** is preferentially heated on a pixel by pixel basis for the entire line or row. Typically, the head **11** moves in a left to right motion or from the leading edge **13***a* to the trailing edge **13***b* of the thermal paper in a controlled fashion, transferring electronically selected colors from the donor material **14** from a raster or bit map function for the next line or row of the hard copy output **13**. In the first step of this sequence all the appropriate yellow thermal media **15** is transferred to the entire area of the thermal hard copy output **13**.

Shown in FIG. **1***b*, the thermal output **13** is temporarily ejected to the customer retrieval shelf **118**. While this ejection step occurs, in a second step the thermal head **11** is repositioned to a position where the leading edge **13***a* of the thermal hard copy output media **13** was initially located.

As shown in FIG. **1***c*, the (virgin) donor media **14** is advanced by the step of simultaneously rotating the spools **16** and **17** in a like direction, respectively, such that the next color to be printed, for example donor media magenta **18**, is in a position between the thermal head **11** and the thermal output **13**.

It should be noted that notwithstanding whether the exact sequence of the above described prior art steps is utilized, the inventor has discovered that a common element in the prior art sequencing is that the thermal output paper or more specifically the thermal output **13** is always ejected at an intermediate step in the sequencing of the prior art printing process as illustrated in FIGS. **1***a*, **1***b*, and **1***c*.

In addition, the improvement represented in the novel invention is based partly on recognition of a unique attribute of the prior art, namely, that prior art thermal printing occurs in a unilateral direction. See, for example, FIGS. **1***a*, **1***b* and **1***c*. First, there is shown the yellow donor media **15**. It is printed from left to right. Next, the paper is ejected, the thermal head **11** is moved in the z direction, the donor media is advanced to magenta **18**, the thermal head **11** is lowered, and finally, the magenta **18** is printed from left to right where required by raster or bit mapping functions on a pixel by pixel or thermal element basis one row at a time until the entire output **13** has been thermally printed. In FIG. **1***b* the thermal output **13** is shown temporarily ejected and in FIG. **1***c* the color specific printing process repeats itself again.

A first preferred embodiment for the mechanism and steps of the novel invention are depicted in FIGS. **2***a* through **2***f*. There is shown an arrangement which utilizes a preferred embodiment thermal printing mechanism **100**. The preferred embodiment thermal printing mechanism **100** contains a thermal head **111** with elements **112**. It also contains a thermally sensitive output media **113** having a leading edge **113***a*, a trailing edge **113***b*, and a customer retrieval shelf **218**. In addition, the preferred embodiment thermal printer mechanism contains donor media **114** which further contains a yellow media section **115** located between a first donor media spool **116** and a second donor media spool **117**. There is also a magenta media section **181**, a cyan media section **119**, and a black media section **120**. All of said media sections are adapted for positioning mechanically between the thermal print head **111** and the thermally sensitive output media **113** by the likewise rotation of the first donor media spool **116** and the second donor media spool **117**. In addition, the thermal print head **111** contains a mounting mechanism, i.e., a universal stepping motor **121**. With the universal stepping motor **121** connected to the thermal print head **111** it is precisely mechanically positioned over the donor media **114** at electronically pre-selected time intervals and at an electronically pre-selected angle as the print head **111** is traveling in a left to right direction and also when the thermal print head **111** is traveling intermittently in an opposite or right to left direction. Thus, a customary stepper motor control for the universal stepping motor **121** is altered and adapted using known and available mechanical means to operate the thermal print head **111** bi-directionally.

A novel sequence of operation for the preferred embodiment of thermal printer mechanism **100** is fully illustrated in FIGS. **2***a*, **2** *b*, **2***c*, **2***d*, **2***e*, and **2***f*. In FIG. **2***a*, the yellow media section **115** is positioned between the thermal head **111** and the output media **113** via the rotation of spools **116** and **117**. The thermal head **111** is positioned intermittently at pre-selected heights and angles by the universal stepper motor **121**. The novel mechanism and thermal printing process initially operates and progresses, respectively, as in the prior art initial sequencing up to the completion of printing all of the yellow color **115** to the thermal output paper edge **113***b*. In the novel printer mechanism **100** and in the method of its operation, instead of temporarily projecting the thermal output **113** onto the customer retrieval shelf **218** (as previously illustrated in FIG. **1***b*), the donor media **114** is advanced as shown in FIG. **2***b* until a magenta media section **181** is positioned over the thermal output media **113** via likewise rotation of the rollers **116** and **117** by employing the use of well known color donor sensors (not shown) and well-known motor control techniques. The thermal head **111** is temporarily moved away in a vertical or z-direction from the advancing donor medial **14** and then lowered prior to restarting the printing process for the next color media, for example, the cyan media section **119** as illustrated in FIG. **2***c*. The bi-directional universal stepper motor **121**, repositions the thermal print head **111** at a pre-selected angle in preparation for the next step of reverse printing (right to left). There is shown in FIG. **2***b* the step wherein the thermal print head **111** actuates a line of thermal printing elements **112***a* at the trailing edge **113***b* and prints the magenta media section **181** sequentially towards the leading edge **113***a* and onto the thermal output media **113**.

Referring to FIG. **2***c*, the thermal head **111** ends up at the left or leading edge **113***a* of the output media **113** after the step of printing the magenta media section **181**. The next step is the macro process of printing the cyan media section **119** in a leading edge **113***a* to trailing edge **113***b* direction (left to right). In FIG. **2***e* is the step of printing the black media section **120** in a reverse right to left direction. This is similar to the previous description of the step of printing the yellow media section **115** and the magenta media section **181**, respectively, as shown and described previously referencing FIGS. **2***a* and **2***b*. In the novel sequencing of steps using the preferred printing mechanism **100**, the step of ejection of the thermal output media **113** as illustrated FIG. **2***f*, occurs only after completion of the steps of printing all colors or media sections.

A first temporary ejection (not illustrated) of the thermal output media **113** can electively occur after the first complete pass of the print head **111** from the leading edge **113***a* to the trailing edge **113***b* (left to right) for the color yellow **115**. Referring now to FIG. **2***c*, on the next sequence of printing from the trailing edge **113***b* to leading edge **113***a* (right to left) another elective second temporary ejection of the thermal output media **113** may occur. In the novel structure and method of the invention, at least three temporary projections are eliminated using bi-directional or bilateral printing. The total printing time T_0 using prior art sequencing is significantly reduced to T_N using the novel invention whereby $T_0 >> T_N$.

In FIG. **3**, there is shown a first alternate or second preferred embodiment wherein a printing mechanism **200** utilizes two separate thermal heads **11***a* and **11***b*. Each is connected to a separate but equivalent universal stepping motor **222** adapted to operate bi-directionally. The print mechanism **200** uses a single donor media spool **316** and an uptake spool **317**. The alternative embodiment is enabled by using the stepper motor **222** as a unidirectional stepper means to control the movement of both heads **11***a* and **11***b*. The heads **11***a* and **11***b* have a first heating element set **312***a* and a second heating element set **312***b*, respectively. Thus, the first alternative embodiment as shown in FIG. **3** is adapted with the additional steps of sequentially moving thermal output media **313** having a leading edge **313***a* and a trailing edge **313***b* in two directions: for example, first in a right to left direction, after which head **11***a* transfers yellow from a yellow media section **315** of a spooled donor media **314** in a left to right direction starting from the leading edge **313***a* of the thermal output media **313**. After yellow has been completely transferred to the thermal output media **313** as previously described, the thermal output media **313** moves in a left to right direction and wherein after which the thermal output media **313** is positioned such that head **11***b* transfers magenta color from the magenta media section **318** of the thermal donor media **314**. As a further alternative step, the spooled donor media **314** can be mechanically sequenced to move in a right and in a left direction to achieve a reduction in the overall size physical size of the spooled donor media **314** when the two heads **11***a* and **11***b* are both utilized to transfer color from the same sections of the spooled donor media **314**.

The novel method is completed by repeating the above step as described for the color yellow such that in addition to sequential printing of the colors yellow and magenta, next the color cyan and then the color black is printed using the thermal elements **312***a* and **312***b*, respectively. Hence, the color cyan (not shown) is printed like the color yellow **315** and the color black (not shown) is printed like the color magenta **318**. Only one output paper ejection step is utilized and required. A substantial time savings of at least 20% is realized due to having only one paper ejection step instead of three as required and utilized by prior art printers.

The novel arrangement of the printing mechanism **200** shown in FIG. **3** provides additional time savings by employing the two separate print heads **11***a* and **11***b* and by the repositioning thereof serially with like serially scheduled or programmed printing times. In the novel assembly and operation of the printing mechanism **200** the first thermal print head **11***a* is repositioned as the second thermal head **11***b* is printing and vice versa.

A third alternative preferred embodiment for the novel operating structure is shown in FIG. **4**. This novel arrangement for a printing mechanism **300** provides at least two adjacent thermal heads **411***a* and **411***b* and at least two sets of related juxtaposed donor media spools **416***a,* **416***b*, and **417***a,* **471***b,* respectively. The printing mechanism **300** is made up of a combination of first and second thermal heads **411***a* and **411***b* and a spooled donor media **414***a* at the left of the hard copy output media **413** and a spooled donor media **414***b* at the right of the hard copy output media **413**. The donor media **414***a* is mechanically and fixedly connected in-between a first donor media output spool **416***a* and a first donor media input spool **417***a*. The donor medium **414***b* is mechanically and fixedly connected in-between two roller mechanisms **416***b* and **417***b*. In this last described embodiment, it is significant to recognize that the printing mechanism **300** is merely a simple exemplary embodiment. This alternative novel embodiment can be expanded to include more than two sets of donor mediums in a donor mechanism and more than two donor mechanisms with a like increase in printing heads such as **411***a* and **411***b*. It should be noted that these two donor mechanisms **416***a* and **416***b* may easily number three, four, or more mechanisms or N mechanisms where N is an integer and N≧2. This embodiment results in an overall improvement in printing time due to the parallel feature of printing with two heads which result in less additive donor spooling time, less additive time to move the thermal head in the z direction and the ability to print 1.5 colors for each complete pass of one of the two thermal heads.

In yet another alternate structure or fourth embodiment, the printing mechanism **300** is as shown in FIG. **4** and described above. With the two printing thermal heads **411***a* and **411***b* and two spools **416***a* and **416***b* of donor media, respectively, at least two colors can be simultaneously printed with simultaneously activated print heads. The novel invention is adapted to accomplish this operational level by employing known stepper motor control technology to simultaneously operate thermal heads **411***a* and **411***b* and/or, alternatively a stepper motor control for the two spools **416***a* and **416***b* of donor media. Basically, one head **411***a* thermally prints all pixels within a row **412***a* at the leading edge of the paper **413***a*. The other or second head **411***b* thermally prints all pixels within a row **412***b* at the trailing edge **413**B of the thermal output media **413**.

In yet a second alternate structure to the 4th embodiment, a mechanical arrangement the thermal heads **411***a* and **411***b* are controlled by a stepper motor (not shown), then thermal head **411***b* is located ½ the distance of the donor medium **414***a* which is mechanically and fixedly connected in-between the two roller mechanisms, for example spools **416***a* and **417***a,* and is adapted to move in the direction of the printing process. The thermal printing head **411***a* is positioned at the leading edge **413***a* of the thermal output media **413**. Both heads **411***a* and **411***b* travel during the same time interval in unison in a reverse direction with the head **411***b* beginning at the trailing edge **413***b* of the thermal output media **413**. The head **411***a* thermally prints ½ or midway across the thermal output media **413** while the **411***b* thermally prints ½ or midway across the thermal output media **413** in a sequencing of steps for operation of the printing mechanism **300**. As thermal head **411***a* completes 100% of its' printing process, thermal head **411***b* will have printed 50% of its' printing process and so on. Therefore, a printing time efficiency equal to or greater than 50% per two thermal colors is achieved since the print head **411***a* completes 50% of its operational task during the same time interval the head **411***b* is operational.

In FIG. **4**, two spools of thermal donor media **414***a* and **414***b* are depicted wherein spool **414**A is shown to contain yellow media **415** and cyan media **419**. The donor media **414***b* is shown to contain magenta media **418** and black media **420**. All media described are thermally activated to print.

The two donor media **414***a* and **414***b* can be increased by one of ordinary skill to four sets of donor media with one of each of four heads adjacent and underneath each set of donor media wherein, for example, spool **414***a* is 100% yellow media; spool **414***b* is 100% magenta media; and by linear extrapolation a spool **414***c* (not shown) is 100% cyan media and interposed between the spools **414***a* and **414***b;* and **414***c* (not shown) is 100% black media and also interposed between the spools **414***a* and **414***b*. The operation of this arrangement results in a time savings of approximately 63% for the entire printing process with an additional increase in efficiency associated with the time savings for head mechanical alignment and positioning of the multiples heads simultaneously and the time savings associated with multiple thermal output media projection times, thus significantly reducing total printing time.

As thermal heads have become cheaper and smaller and are now more widely used in consumer applications, the third embodiment is economically viable for large scale production. It should be noted that it is well known to those in this art that with certain known types of thermal output media, the density of printing elements or pixels is increased, sometimes by a factor of 2 to print four separate pixels in an equivalent 300 dpi density due to the color science of printing one color before another and vice versa in different areas of the same output media.

The invention has been described in detail with particular reference to a first preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the novel invention and subject to the doctrine of equivalents.

PARTS LIST

10 prior art printer mechanism
11 thermal print head
11*a* first thermal print head
11*b* second thermal print head
12 thermal heating elements
13 hard copy output
13*a* leading edge of hard copy output
13*b* trailing edge of hard copy output
14 donor material
15 yellow donor media
16 first donor media spool
17 second donor media spool
18 donor media magenta
100 first thermal printing mechanism
111 thermal print head
112 heating elements
113 thermally sensitive output media
113*a* leading edge of thermally sensitive output media
113*b* trailing edge of thermally sensitive output media
114 donor media
115 yellow media section
116 first donor media spool
117 second donor media spool
118 customer retrieval shelf
119 cyan media section
120 black media section
121 universal stepping motor
181 magenta media section
200 first alternate printing mechanism
218 customer retrieval shelf
222 universal stepping motor
312*a* first heating element set
312*b* second heating element set
313 thermal output media
313*a* leading edge of thermal output media
313*b* trailing edge of thermal output media
314 spooled donor media
315 yellow media section
316 single donor media spool
317 uptake media spool
318 thermally sensitive donor media with magenta color donor area
319 thermally sensitive donor media with cyan color donor area
320 thermally sensitive donor media with black color donor area
300 alternate third thermal printing mechanism
411*a* first thermal print head
411*b* second thermal print head
412*a* heating elements of thermal head **411***a*
412*b* heating elements of thermal head **411***b*
413 thermally sensitive hard copy output media
413*a* leading edge
413*b* trailing edge
414*a* spooled donor media
414*b* spooled donor media
415 thermally sensitive donor media with yellow color donor area
416 first donor media spool
417 second donor media spool
416*a* first donor media output spool
416*b* second donor media output spool
417*a* first donor media input spool
417*b* second donor media input spool
418 thermally sensitive donor media with magenta color donor area
419 thermally sensitive donor media with cyan color donor area
420 thermally sensitive donor media black color donor area

What is claimed is:

1. A method of operating a thermal printer to produce at least one output sheet with a multiple color image thereon, the method comprising:

providing in a printing zone a donor sheet material having a first substance having a first distinct colorant and a second substance having a second distinct colorant, the donor sheet material being supported between a single supply roll and a single take-up roll and the donor sheet extending for a full width dimension of the output sheet;

providing first and second printing heads, the first and second printing heads having recording elements adapted to engage the donor sheet material to selectively transfer colorant as an image to the output sheet; and

operating the first and second printing heads to provide linear movement to each of said first and second printing heads while in engagement with the donor sheet material so that each printing head transfers colorant to said output sheet to transfer a multiple color image to the output sheet without removing the output sheet to a position remote from the printing zone until after the multiple color image is transferred thereto.

2. A method of operating a thermal printer to produce at least one output sheet with a multiple color image thereon, the method comprising:

providing in a printing zone a donor sheet material having a first substance having a first distinct colorant and a second substance having a second distinct colorant, the donor sheet material being supported between a single supply roll and a single take-up roll;

providing first and second printing heads, the first and second printing heads having recording elements adapted to engage the donor sheet material to selectively transfer colorant as an image to the output sheet;

operating the first and second printing heads to provide linear movement to each of said first and second printing heads while in engagement with the donor sheet material so that each printing head transfers colorant to said output sheet to transfer a multiple color image to the output sheet without removing the output sheet to a position remote from the printing zone until after the multiple color image is transferred thereto; and wherein linear movement is provided to said second printing head while in engagement with the donor sheet material so that the second printing head transfers colorant to said output sheet during return movement of said first printing head to a position by an edge of said output sheet.

3. The method according to claim **2** and wherein during said linear movement of said first printing head a first colorant only is transferred to said output sheet and during said linear movement of said second printing head a second colorant only and of a different coloration from said first colorant is transferred to said output sheet and wherein said output sheet is moved after said first linear movement to position the output sheet to receive said second colorant for printing by said second printing head.

4. A method of operating a thermal printer to produce at least one output sheet with a multiple color image thereon, the method comprising:

providing in a printing zone a donor sheet material having a first substance having a first distinct colorant and a second substance having a second distinct colorant, the donor sheet material being supported between a single supply roll and a single take-up roll;

providing first and second printing heads, the first and second printing heads having recording elements adapted to engage the donor sheet material to selectively transfer colorant as an image to the output sheet;

operating the first and second printing heads to provide linear movement to each of said first and second printing heads while in engagement with the donor sheet material so that each printing head transfers colorant to said output sheet to transfer a multiple color image to the output sheet without removing the output sheet to a position remote from the printing zone until after the multiple color image is transferred thereto; and

wherein the first and second printing heads operate to transfer colorant of the same color to the output sheet.

5. A method of operating a thermal printer to produce at least one output sheet with a multiple color image thereon, the method comprising:

providing in a printing zone a donor sheet material having a first substance having a first distinct colorant and a second substance having a second distinct colorant, the donor sheet material being supported between a single supply roll and a single take-up roll;

providing first and second printing heads, the first and second printing heads having recording elements adapted to engage the donor sheet material to selectively transfer colorant as an image to the output sheet;

operating the first and second printing heads to provide linear movement to each of said first and second printing heads while in engagement with the donor sheet material so that each printing head transfers colorant to said output sheet to transfer a multiple color image to the output sheet without removing the output sheet to a position remote from the printing zone until after the multiple color image is transferred thereto; and

wherein during said linear movement of said first printing head a first colorant only is transferred to said output sheet and during said linear movement of said second printing head a second colorant only and of a different coloration from said first colorant is transferred to said output sheet and wherein said output sheet is moved after said linear movement of said first printing head to position the output sheet to receive said second colorant for printing by said second printing head and further wherein said linear movement of said first printing head is in a direction opposite to a direction of said linear movement of said second printing head.

6. A method of operating a thermal printer to produce at least one output sheet with a multiple color image thereon, the method comprising: providing in a printing zone a first donor sheet material having a first substance having a first distinct colorant and a second substance having a second distinct colorant the first donor sheet material being supported between a first set of a single supply roll and a single take-up roll and the first colorant having different coloration from the second colorant; providing in the printing zone a second donor sheet material having a third substance having a third distinct colorant and a fourth substance having a fourth distinct colorant the second donor sheet material being supported between a second set of a single supply roll and a single take-up roll and the third colorant having different coloration from the fourth colorant; providing first and second printing heads, the first and second printing heads having recording elements adapted to engage respectively the first and second donor sheet materials to transfer colorants from the respective donor sheet materials as an image to the output sheet; operating the first and second printing heads to provide linear movement to each of said first and second printing heads while each is in engagement with a respective donor sheet material so that each printing head operates to transfer at least two colorants to said output sheet to transfer a multiple color image of at least three colors to the output sheet without removing the output sheet to a position remote from the printing zone until after the multiple color image is transferred thereto.

7. The method according to claim **6** and wherein each printing head at any one time operates to transfer only one colorant.

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